Improving the Resilience to Interference of a GNSS Reference Station

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- when it has to be right

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Outline

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- What is Interference for GNSS Reference Station?
- Interference Sources
- Leica Geosystems ITK
- Test Case Examples
- Summary

What is Interference for GNSS Reference Station

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- **Interference is a phenomenon where undesired signals enter the GNSS reference station receiver and mix with the satellite navigation signals to disrupt the operation of the receiver, causing:**
  - Partial or total loss of lock
  - Reduced and/or noisy SNR
  - Reduced ability of the receiver to properly operate to provide reliable raw observation data, corrections, and compute a position.

Interference Sources

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Increasing amount of sources of GNSS interference

- **In-Band:** Within band of GNSS signal.
  Intentional jammers, other RF spectrum users (legal or not)

- **Near-Band:** Close to band of GNSS signal.
  Includes legal transmissions such as
  Globalstar and long-range air traffic control radar

- **Out of band Harmonics:** Far removed transmitters that may have spurious harmonic emissions overlapping GNSS band

- **Self Interference:** Electronics integration often requires solving in-band, near-band and out of band harmonics from within the product itself

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Leica Geosystems ITK

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- **ITK stands for Interference Tool Kit**
- **A software upgrade on Leica's GR30/50 reference station receivers:**
  - **Allows the user to visualize the frequency spectrum:**
    - Easily detects interference by visual inspection
  - **Automatic Interference detection**
  - **Adaptive interference rejection technologies for strong interference situations using three methods:**
    - HDR mode - High dynamic range mode performing a wideband mitigation
    - Band pass filter
    - Adaptive notch filter

Test Case Examples

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Test case examples:

- In band Continuous Wave (1582.5 MHz, -44 dBm)
- Out of band Narrowband (1625 MHz, 1.2288 MHz CDMA, -14 dBm)
- Out of band Wideband (1625 MHz, 10 MHz, LTE, -28 dBm)

Receiver performance before and after mitigation:

- Average GPS L1 C/No, over all satellites tracked for each epoch
- Number of Satellites tracked
- RTK position accuracy

Test Case Examples

In Band Continuous Wave

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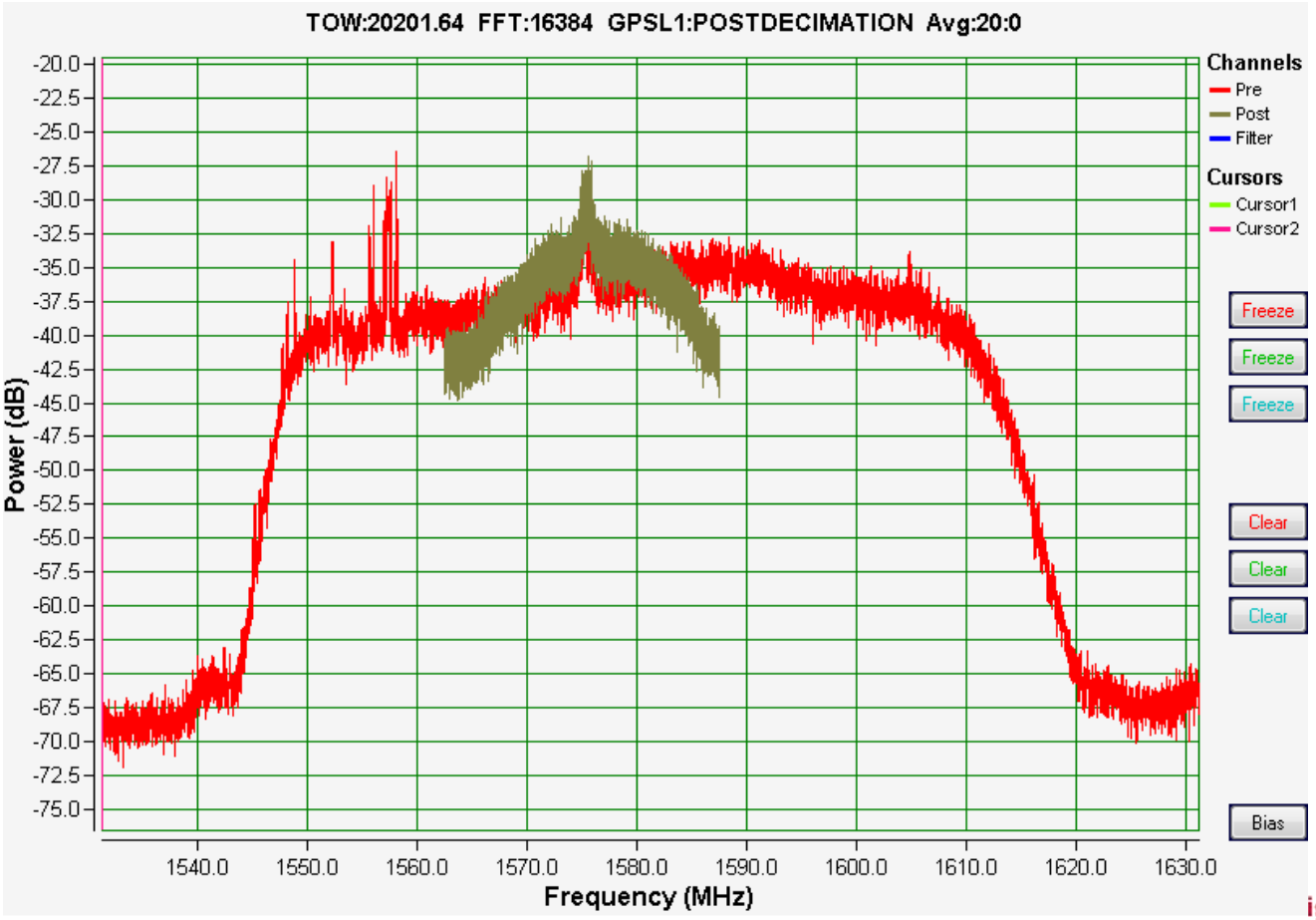
Normal/Healthy GPS L1 Spectrum



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Test Case Examples

In Band Continuous Wave

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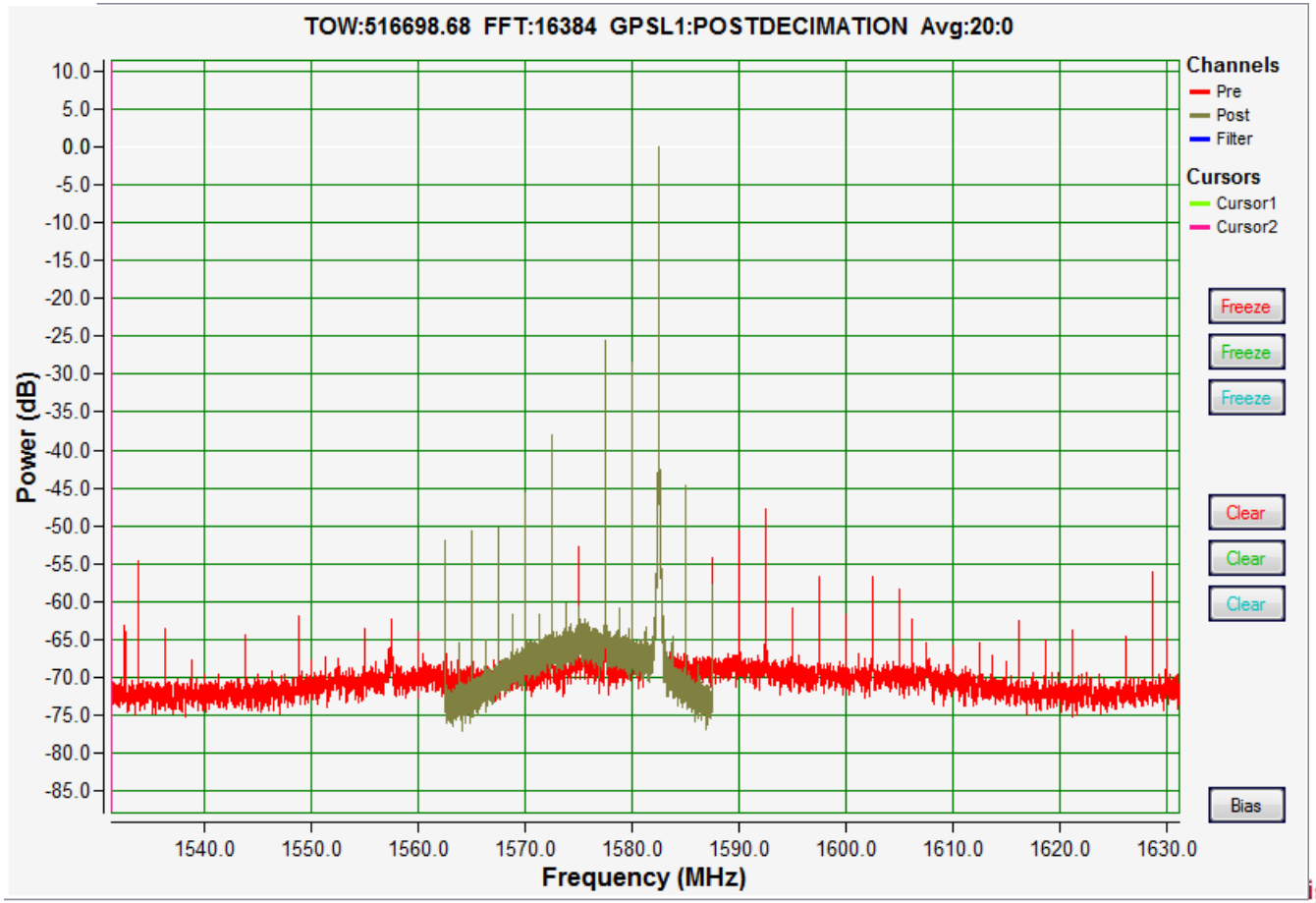
In Band Continuous Wave Interferer



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Test Case Examples

In Band Continuous Wave

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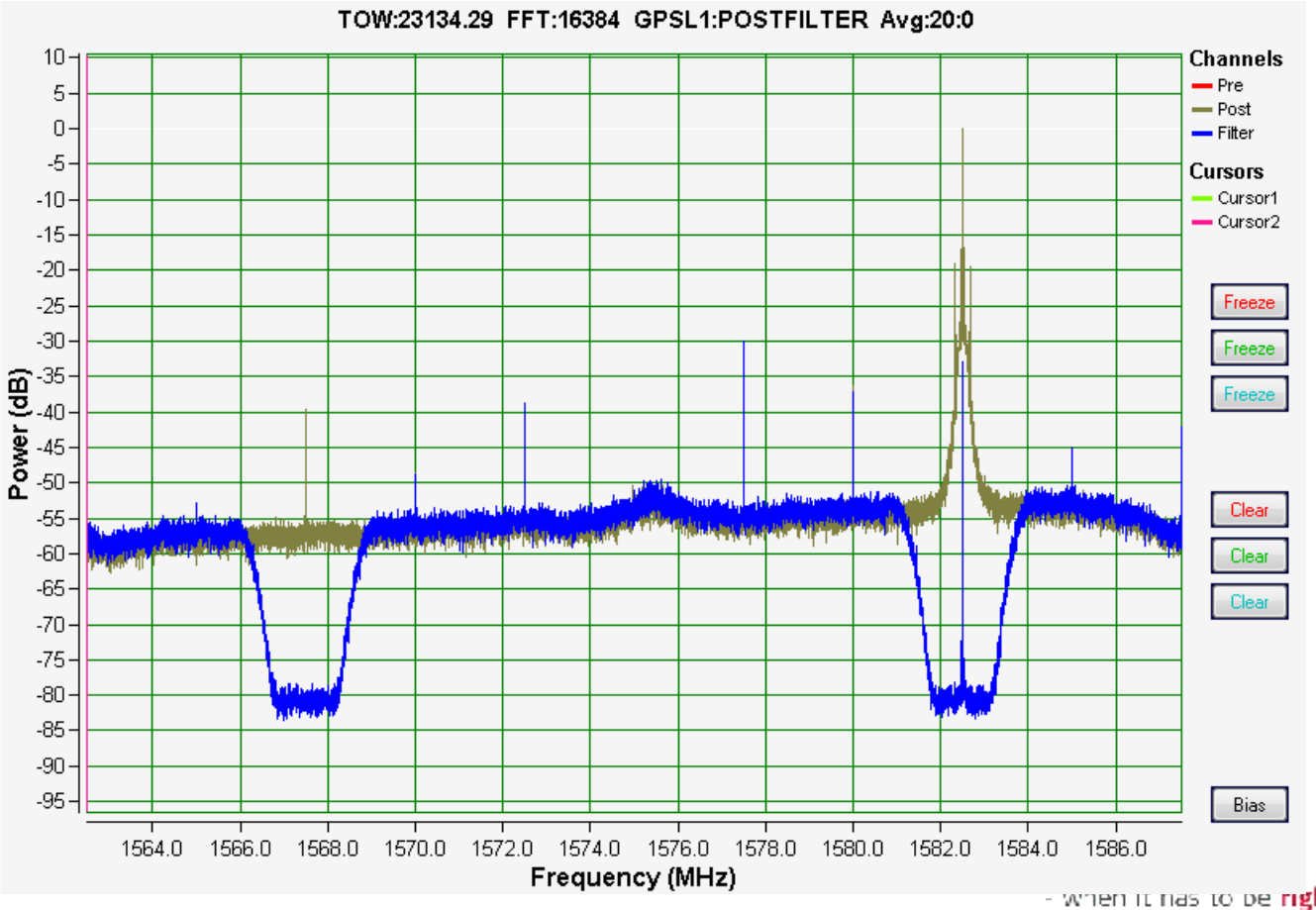
Mitigated In Band CW Interferer (HDR mode & Notch filter applied)



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Test Case Examples

In Band Continuous Wave

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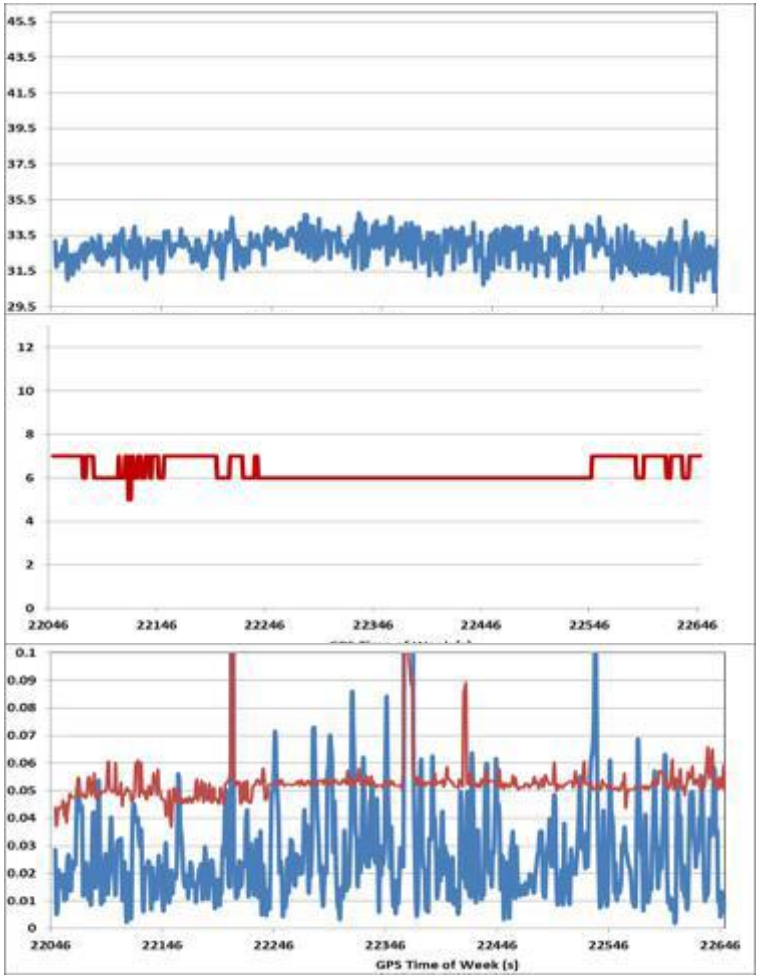
Before Mitigation

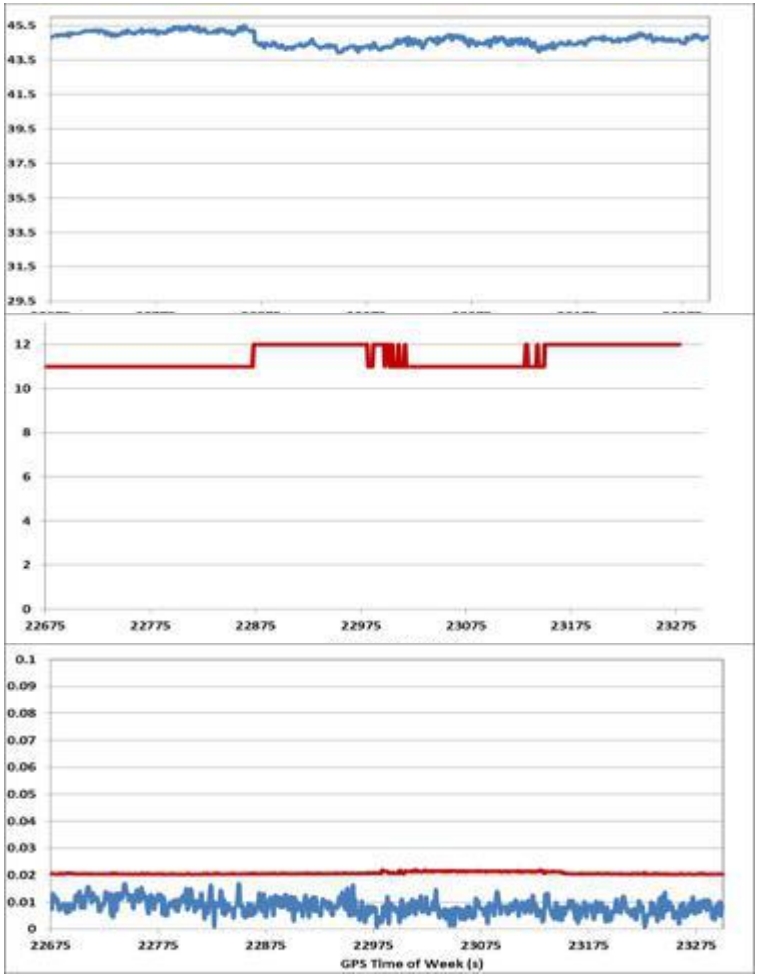


Average C/No (dB-Hz)

Satellites Tracked

3D RTK Position Error (m)

After Mitigation



Test Case Examples

Out of Band Narrowband

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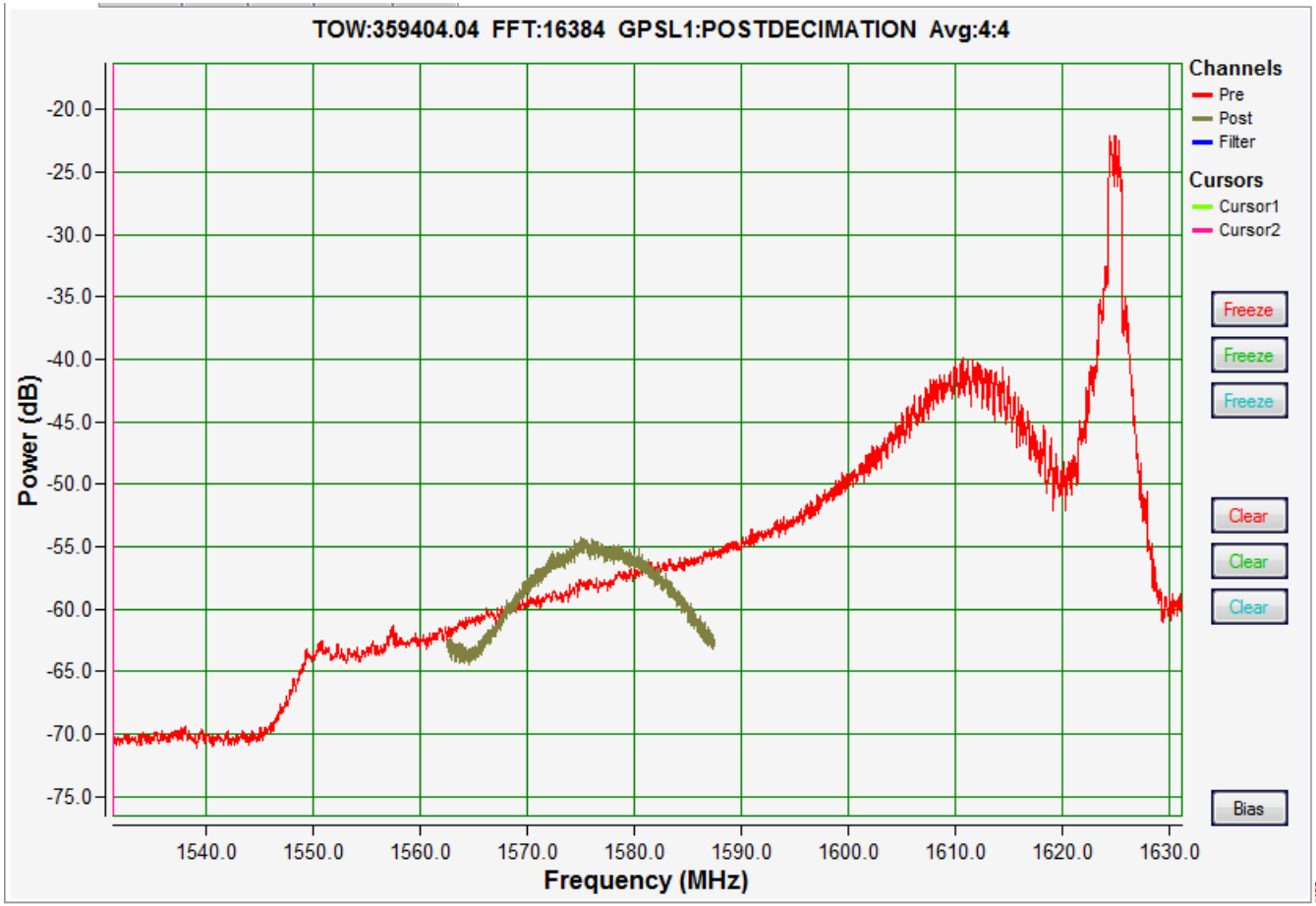
Out of Band Narrowband Interferer (e.g. GlobalStar)



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Test Case Examples

Out of Band Narrowband

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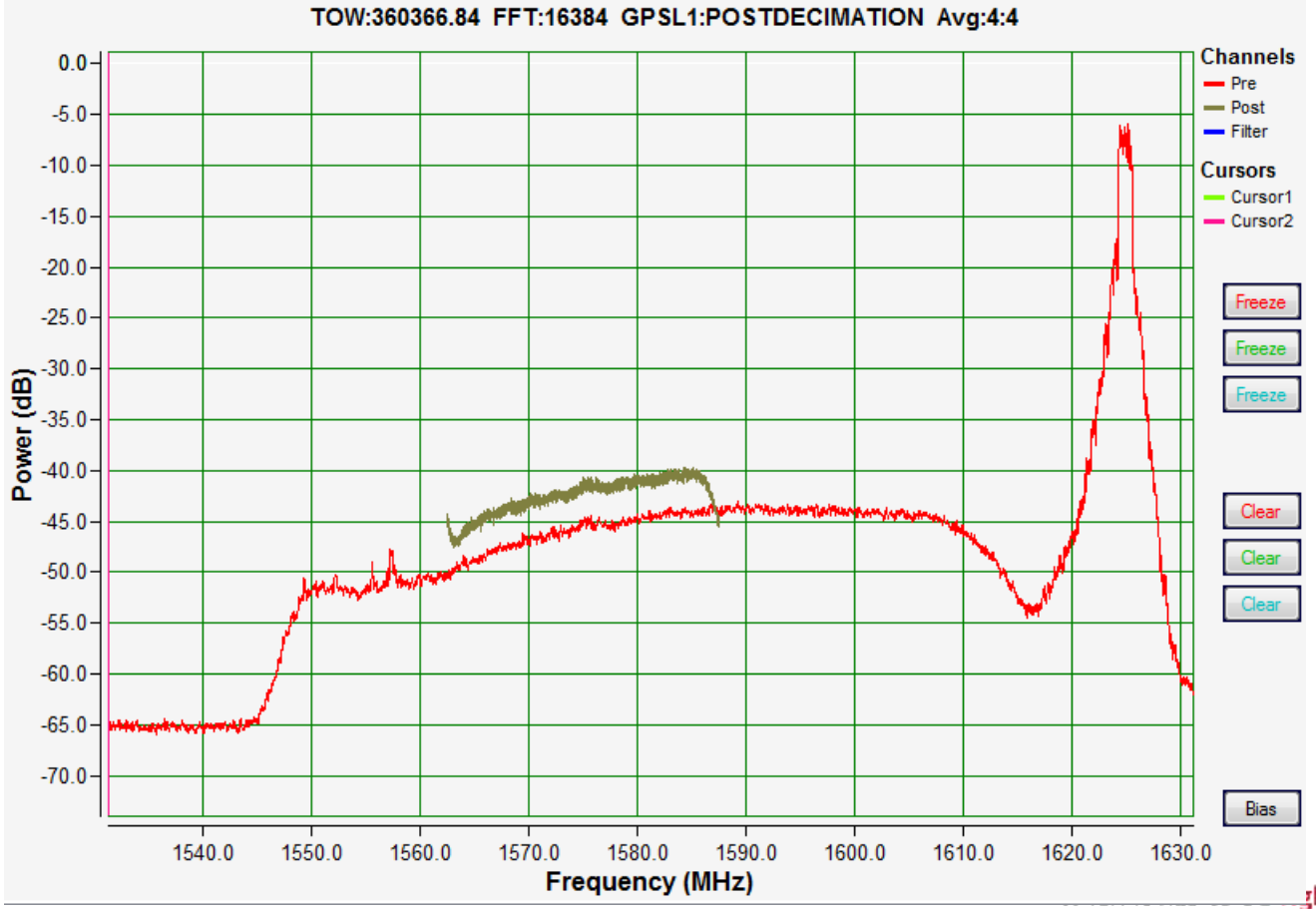
Mitigated Out of Band Narrowband Interferer (HDR Mode)



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Test Case Examples

Out of Band Narrowband

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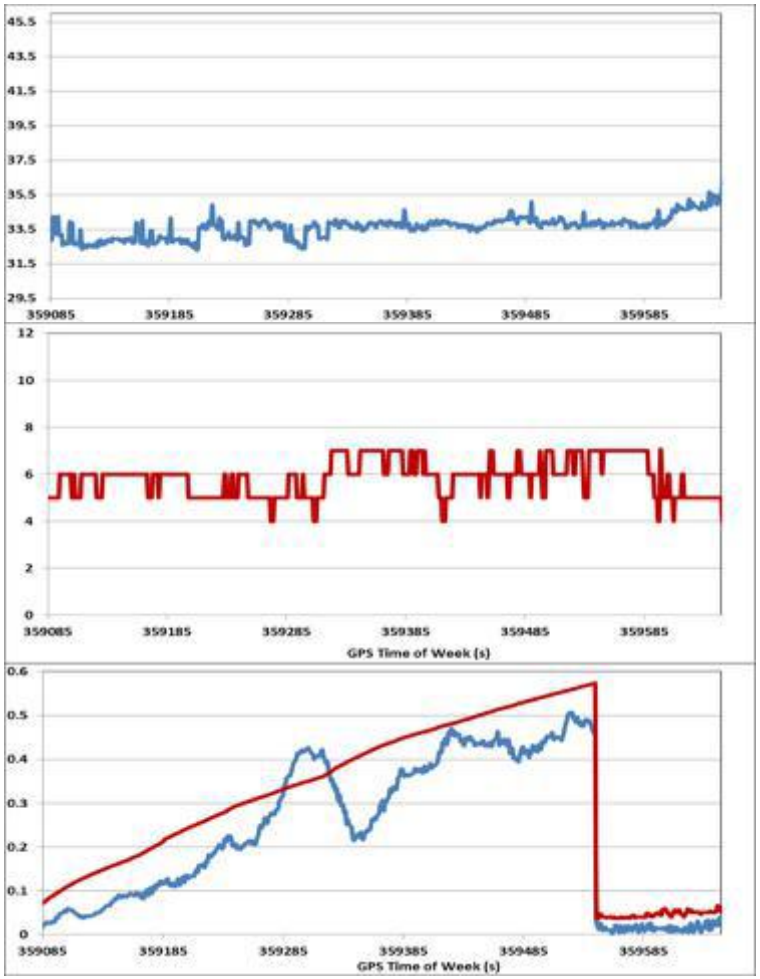
Before Mitigation

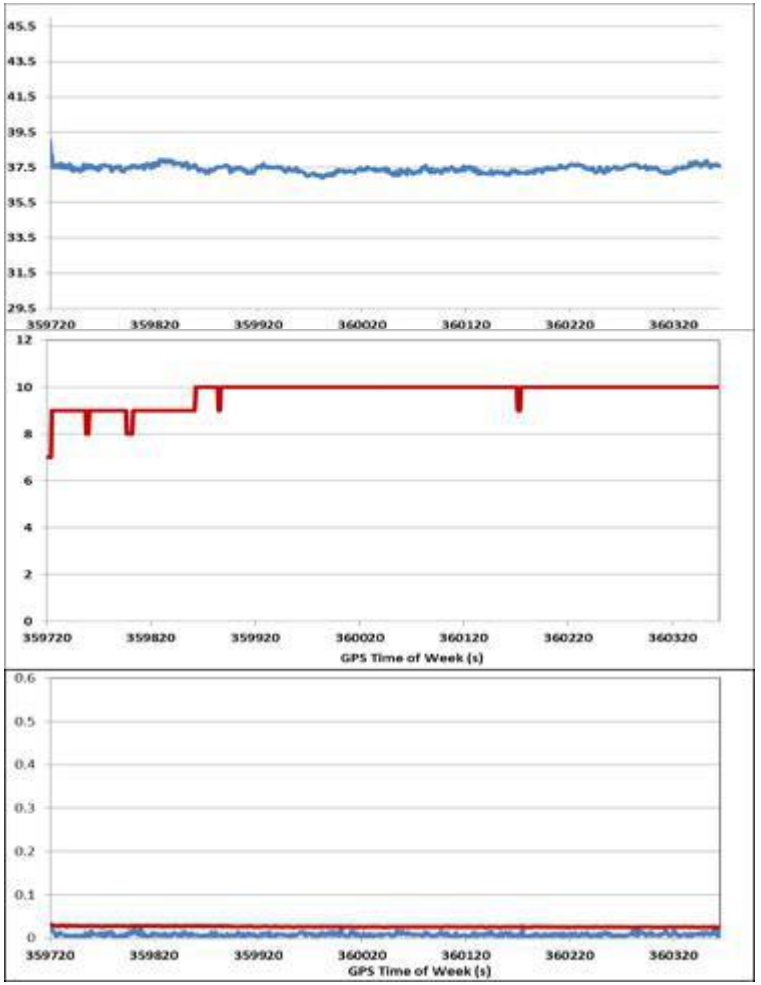


Average C/No (dB-Hz)

Satellites Tracked

3D RTK Position Error (m)

After Mitigation



Test Case Examples

Out of Band Wideband

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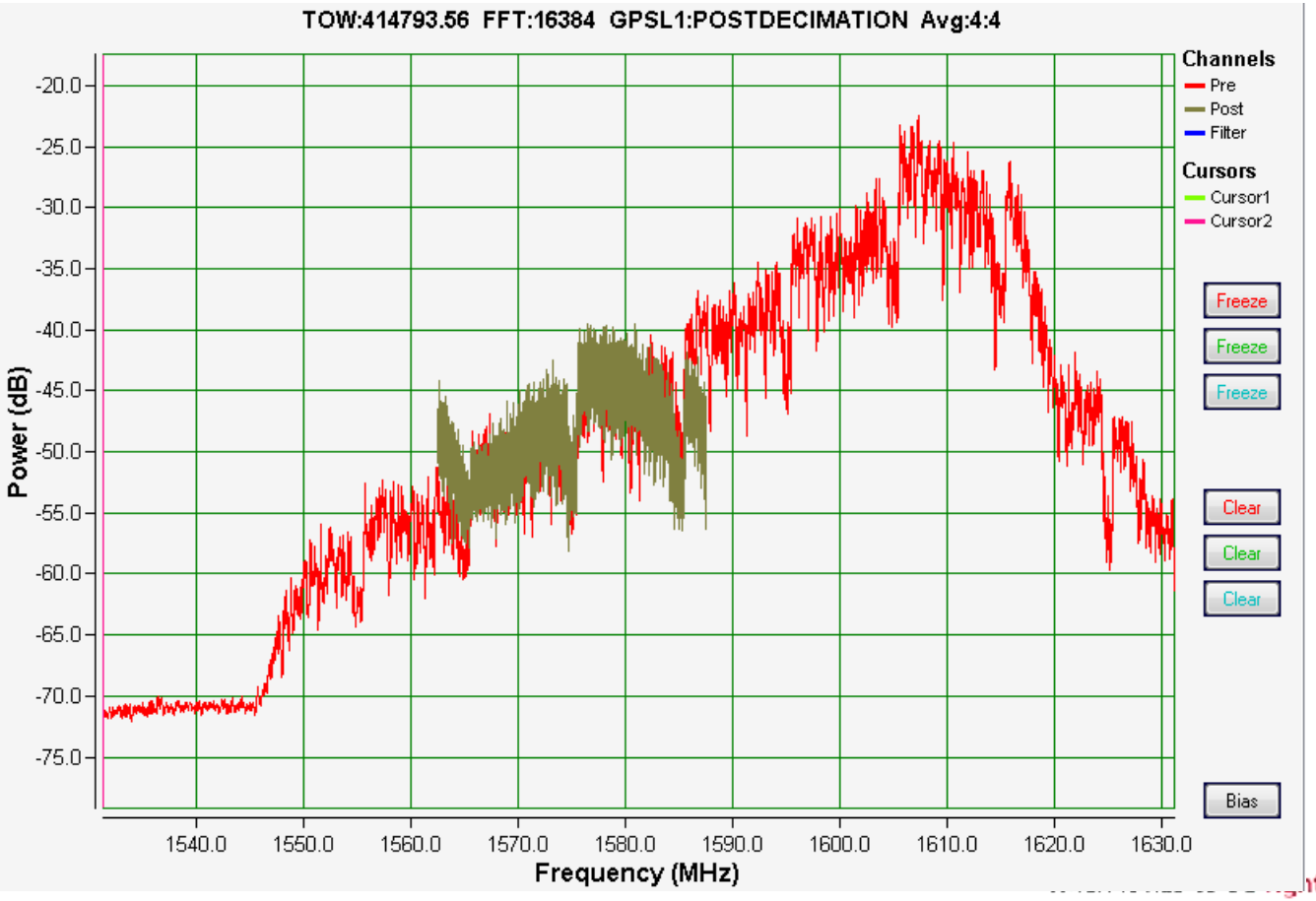
10 MHz LTE Centred at 1625 MHz



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Test Case Examples

Out of Band Wideband

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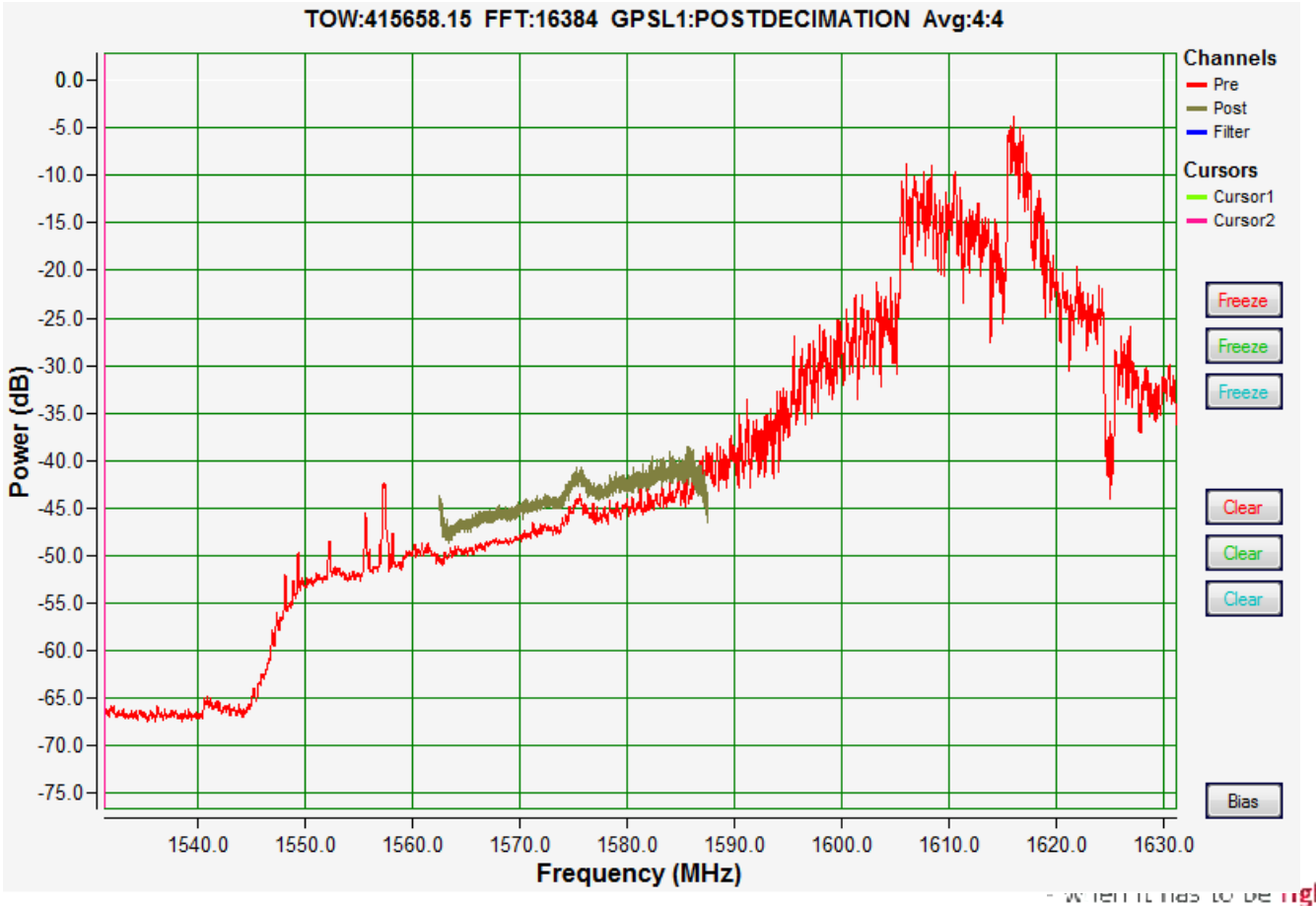
Mitigated OOB WB Interferer (HDR Mode)



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Test Case Examples

Out of Band Wideband

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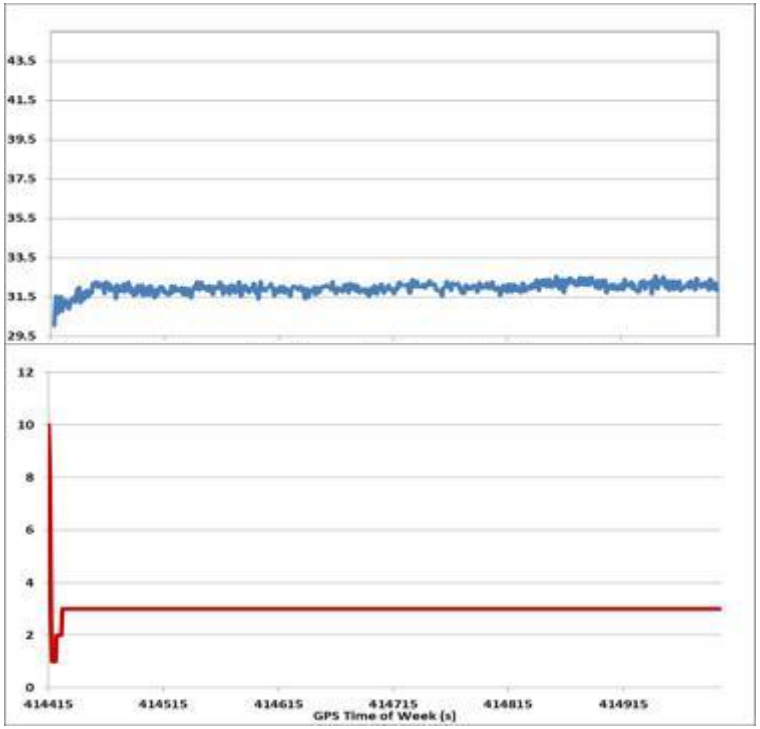
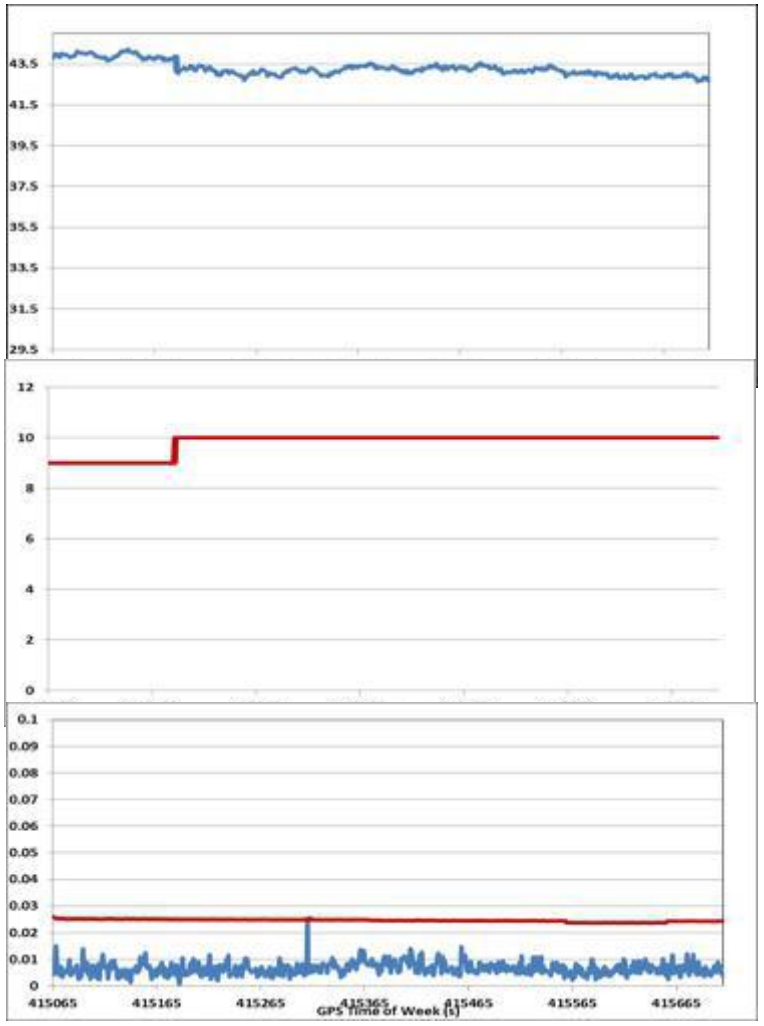
Before Mitigation



After Mitigation



Average C/No (dB-Hz)

Satellites Tracked

3D RTK Position Error (m)

No Position

Summary

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Interference Tool Kit (ITK)

- **Power Spectrum Visualisation and Mitigation technologies for Leica's GR30 / GR50 reference station receivers**
- **Demonstrated and will become available as future software upgrades**
- **Efficient interference rejection of strong interferers becomes possible**
  - In-Band Continuous Wave
  - Out of Band – Narrow band
  - Out of Band – Wide band
- **Satellite tracking and signal quality can be largely preserved**
- **High quality Precise Positioning remains possible**

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The Leica Spider family of products provide all you need for smart solutions.
From single base stations to comprehensive infrastructure RTK networks.

GNSS Networks and Reference Stations

Smart Solutions from Leica Geosystems

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